Name: _____

1. (1 pt.)
   - **Read all material carefully.**
   - *If in doubt whether something is allowed, ask, don't assume.*
   - You may refer to your books, papers, and notes during this test.
   - E-books may be used *subject to the restrictions* noted in class.
   - Computers are not permitted, except when used strictly as e-books.
   - Network access of any kind (cell, voice, text, data, ...) is not permitted.
   - Write, and draw, carefully. Ambiguous or cryptic answers receive zero credit.
   - Use class and textbook conventions for notation, algorithmic options, etc.

   Write your name in the space provided above.

WAIT UNTIL INSTRUCTED TO CONTINUE TO REMAINING QUESTIONS.

Do not write on this page below this point.

Q	Full	Score
1	1	
2	5	
3	15	
4	15	
5	9	
total	45	

2. (5 pts.) Provide a *formal definition of the language* consisting of strings over the alphabet $\{\mathtt{a}, \mathtt{b}, \mathtt{c}, \mathtt{d}\}$ whose length is greater than 4 and in which the second letter (from the left of the string) and the second-from-last letter (second position from the right of the string) are the same.

3. (15 pts.) Provide a NFA that recognizes the language of Question 2 (or prove that no such NFA exists): **Prove, as precisely as possible,** that the NFA recognizes the language. [Hint: Use a method similar to that used in a recent class meeting.]

[additional space for answering the earlier question]

4. (15 pts.) Provide a DFA that is equivalent to the NFA of Question 3. **Prove the equivalence, as precisely as possible.**

5. (9 pts.)

   (a) Convert the NFA of Question 3 to a GNFA.

   (b) Using the textbook's method, reduce the number of states in the above GNFA by one.

[additional space for answering the earlier question]